

Sustainability indicators for Small and Medium-sized Enterprises (SMEs) in the transition to provide Product-Service Systems (PSS)

Erik Sundin^{a*}, Elin Nässlander^a and Alan Lelah^b

^a*Division of Manufacturing Engineering, Department of Management and Engineering, Linköping University, SE-58183 Linköping, Sweden*

^b*University Grenoble Alpes, G-SCOP, Grenoble, France*

Abstract

Product-Service Systems (PSS) were developed as more sustainable alternatives to traditional product sales, especially through better and more intensive use of materials. Some companies currently use this business model successfully, while others are still in the process of transforming to PSS. The change from providing a product to providing a service has proved to be rather difficult and actual sustainable benefits have been questioned.

The research described in this paper was part of the ServINNOV project. The initial idea was to find out if, and how, indicators could help in the move to PSS. Indicators could give a clearer picture of the situation and monitor progress during the transition period. Indicators could also help companies focus on their core activities, and determine whether a PSS offering really helps them to become more sustainable. The study covers an overall view of sustainable indicators, with a focus on environmental issues.

The research for this paper was carried out through both theoretical and empirical studies. Empirical findings were obtained from interviews with three companies, all of them working with PSS on different levels. The results will guide transition to provide more sustainable PSS.

Keywords: Product-Service Systems; PSS; Sustainability Indicators; Scenarios

1. Background

In the PSS research field there are many different methods to help companies when developing their offerings. One of these methods, currently under development, is the use of scenarios. Scenarios can help companies to concretize their progress by enabling them to better understand their current situation, as well as where they want to be and where they are, so that they can make the right decisions to reach their goals. When using scenarios it is useful to measure both progress and development to see if the company is moving in the right direction; one way of doing so is by using indicators. Indicators are used to follow up on the different key interests that the companies would like to reach. Although these indicators are individual to each company, the aim of this research is to find indicators that are more suitable when developing PSS so that companies in the transition towards providing PSS can get assistance in their choice of indicators when developing scenarios. The scenarios will be developed to help SMEs as they make decisions to develop better and more sustainable PSS offerings

2. Objective

The objective of this paper is to determine which sustainability indicators are important for three SMEs in different phases in their development towards providing PSS. The study will be carried out in the form of interviews with personnel from the three SMEs.

The study aims to build a scenario reliant on different sustainability indicators, work which will be further developed by researchers in the French-funded ServINNOV project.

3. Methodology

A literature review was conducted via the Ebsco Discovery Service search engine. The keywords used were e.g. “product service system AND environment”, “PSS AND environment”, “PSS AND sustainability”, and “sustainability indicators”. To give an idea of the scope of the search engine, a search on “product-service system AND sustainability” returned around 6500 hits. Research papers were then selected according to their relevance and publication year.

In order to expand the study and verify the results from the literature review, empirical research was performed. The empirical research was carried out through a series of interviews trying to seek answers to what sustainability indicators the three SMEs working with PSS were most interested in using. The main objective of the interviews was to determine if the SMEs used any indicators, and if they found the indicators from the literature review interesting. The idea was also to make the interviewees reflect on their own situation to determine the reason behind their choice of indicators.

4. Scenarios

The term scenario is “*considered a synonym for an overall vision of something complex and articulated – a set of possible conditions, or transformations, affecting the domain under consideration*” [1]. Building scenarios is a process that can help companies and business networks when developing new sustainable products, PSS or other businesses [1]. As development of PSS offerings in many cases is realized with several different actors, it is a necessity that the different actors have a shared understanding of the problem, and that they have a shared vision so that they can ultimately come up with a shared solution. Furthermore, the nature of the system change needed to achieve sustainability includes social, cultural, technological and organizational aspects [2]. To be able to make such a transition, good communication is essential and could be facilitated by building scenarios [1]. There exist several different types of scenarios, for example genius forecasting, trend extrapolation, incasting, and probability trees [3]. Previous work within the servINNOV project studied how scenarios were suitable for helping decision making in SMEs that want to move to PSS business models. They outlined that in this process, indicators can play an important role [4].

5. Sustainability Indicators

According to Olsthoorn et al. [5], indicators are simple units of measure that are critical when making decisions in a complex environment; as previously mentioned, this is the case when developing a PSS offering. This is because indicators can be used to give a reliable and comprehensive picture of a situation and trend [6]. The OECD [7] defines an indicator as “*a parameter, or a value derived from parameters, which points to, provides information about, or describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value*”. The OECD [7] also points out two utilities for indicators: to reduce the number of parameters and measurements needed to provide a picture of a situation, and to simplify communication. The OECD [7] also emphasizes that the utilities of an indicator set depend on the size of the indicator set, and that indicators should be seen as “*the best knowledge available*”, although they may not always have a solid scientific basis. Joung et al. [8] describe the following criteria for indicators: measurable, relevant, understandable reliable/usable, data accessible, timely manner, and long-term oriented.

In the report Environmental Indicators for Environmental Performance Reviews [7], the criteria are deeper and more developed. The OECD [7] clarifies in the report that indicators should enable international comparison and be based on international standards, updated regularly, and linked to economic models and information systems. According to Moldan et al. [9], the problem is not the availability of data to measure the indicators, but rather the selection and use of the appropriate indicators.

5.1 Environmental indicators for sustainability

Sustainability covers three poles, environmental, economic and social. In the Global Reporting Initiative, indicators are distinguished according to three categories of performance indicators, namely economic, environmental and social. The last category is sub-divided into four sub-categories: labor practice and decent work; human rights; society; and product responsibility [10]. A different classification is provided in ISO 26000 with seven core subjects: organizational governance; human rights; labor practices; environment; fair operating practices; consumer issues; and community involvement and development [11].

This paper focuses more on environmental issues. Table 1 compares 16 environmental sustainability indicators proposed by 6 different sources.

Different sets of indicators are available from different organizations and reports. Table 1 compares 16 environmental sustainability indicators proposed by 6 different sources. Most of the indicators were present in all the sources. Similar indicators were merged into one indicator; e.g., “emissions” from the Indicator Protocol Set Global Report Initiative [10] and “air pollution” from Olsthoorn et al. [5] were merged into “air quality”.

Table 1 shows how different sources exert stress on different indicators, but globally, the main objectives of the indicators are similar.

Table 1. Environmental sustainability indicators used by different sources where A = CEI – OECD Environmental Indicators Development, Measurement and Use, Core Environmental Indicators (2003), B = COES – Current Opinion in Environmental Sustainability, How to Understand and Measure Environmental Sustainability: Indicators and Targets (2010), C = EIFB - Environmental Indicators for Business: a Review of the Literature and Standardization Methods [1], D = IPSGRI - Indicator Protocol Set Global Report Initiative [7], E = ISO26000 [6], F = KEI - OECD Environmental Indicators Development, Measurement and Use, Key Environmental Indicators (2003).

Environmental sustainability indicator	A	B	C	D	E	F
Climate change	X	X	X	X		X
Ozone layer depletion	X	X	X	X	X	
Eutrophication	X	X	X		X	
Acidification	X	X	X	X	X	
Toxic contamination	X		X	X	X	
Air quality	X	X	X	X		X
Biodiversity	X	X	X	X	X	X
Cultural landscapes	X	X	X		X	
Waste generation	X	X	X	X	X	X
Water resources	X	X	X	X	X	X
Forest resources	X	X				
Fish resources	X	X	X			X
Soil degradation	X	X	X			
Material resources	X		X	X	X	
Transportation		X		X		
Energy use		X		X	X	X

6. Business cases

In this section, the information extracted from the business cases at the three companies, CA, CB and CC, is summarized. Table 2 describes the case company characteristics.

Table 2. Characteristics of the case companies studied.

Characteristic	CA	CB	CC
Years in business	60	10	10
No. of employees	50	18	1
Industrial sector	Compressed air, hydraulic, temporary electricity and primary vacuum installations for construction works	Electrification and automation for quarries and public construction works	Sanitary water supply for health institutions and other leisure centers
PSS experience	Has used it successfully but had difficulties in convincing new customers	Has used similar business models to PSS. Hard to convince new customers	Is trying to implement PSS for its products but has had difficulties in convincing large hospitals
Sustainability interests	Economic Environmental Social	Economic Environmental Social	Environmental Social
Indicator experience	Uses on a regular basis	Has used	Does not use

6.1 Company A

Company A (CA) has four main business areas: it provides compressed air, hydraulics, temporary electric power and primary vacuum plants. The company designs and provides the complete installation, including the organization of the plant, dimensioning and building the park of machines, standby machines and other equipment necessary to run the plant. It also ensures rental, repair and maintenance of the equipment to satisfy the customer's needs in each of the above-mentioned business areas, although it does not manufacture the actual machines itself. The company's customers include industries, construction projects, communities and, to a small extent, individuals or other smaller entities such as garages.

CA and sustainability

Historically, CA has always been concerned by the continuity of employment and activities. Given the nature of the equipment it provides, it has also been following the electrical consumption of its machines. After taking interest in PSS and close collaboration with academic partners, CA is now becoming increasingly concerned with the environmental consequences of its activities. The company currently works on integrating the three different aspects of sustainability in its business. In the social aspect of sustainability, the company is mostly focused on its employees and their health and development. The company uses

indicators to measure its progress in different fields, and is currently working to integrate the environmental aspects of sustainability into the indicators it is currently using. The manager of the company has sustainability as one of his core goals. The company has been certified with the Lucie label, a sustainable development label in France, showing that the company is working with sustainability according to the ISO 26000 (www.labellucie.com).

CA and indicators

CA uses a great number of different indicators, which it follows up on and measures each month. The company has indicators, which it calls footprints, in six different fields: patronage, management of resources, suppliers, customers, organization and products. For each footprint it has defined three different indicators. These indicators were developed internally at the company with an external model called SYBIO (sybio.fr). The indicators are only used internally, and they enable the company to see how well it performs regarding the different aspects of **patronage** (financial endowment, number of apprentices and trainees, optimized business sustainability profile), **economy** (treasury, result of work, investment), **suppliers** (compliance from machine manufacturer, service, diversity of supply), **customers** (customer satisfaction, recurrence, successful tenders), **organization** (attendance, skills and knowledge, flow of information), and **products** (amount of innovation in the offers, the reliability of deals, use of equipment).

Most of these indicators do not show how sustainable the company actually is, but they do provide a picture of how the company uses indicators. Apart from the indicators that it already uses, the company mentioned two other environmental indicators during the interview that it found useful to use: **amount of transportation** and **amount of energy used**. Both of the indicators affect the environmental part of sustainability. The interviewee found the amount of transportation useful, as it could help them to visualize the company's transportation in order to lower the consumption of fuel, and thus decrease the company's impact on the climate. One way of measuring this could be to use GPS devices on its vehicles, while another could be to have a system to measure how much fuel the vehicles consume. The amount of energy used could both affect the company's office spaces and workshop, as well as how much its machines consume. Other indicators that were discussed during the interview, such as the amount of material used, are rather difficult to comprehend as the basic material used in the plants are already machines and other products. A relevant indicator would have to be concerned with the specifications of the machines used or the power necessary for running them.

6.2 Company B

Company B's (CB) business area is to provide electrification and automation to quarries and public construction works. Although it provides a variety of different software and products, the main ones discussed during the interview were Tamisoft, a service that measures the sizes of rocks with lasers at quarries; a machine that makes methane gas; and the making of electricity out of agricultural waste. The company has also developed a system to decrease the amount of energy needed when drying hay with the help of automation.

CB and sustainability

CB has always been concerned with socio-economic aspects, especially the status of its employees. The company works with sustainability in different aspects, both on an organizational level and with the products and services it provides. It is currently revising its status from a limited company with eight shareholders, where the manager is the main shareholder, to a French Cooperative Participative Societies (SCOP). Among other things, this means that the staff elects the manager, but it also affects the profit distribution, where all employees will share any profit (www.les-scop.coop/sites/fr/). This also increases the employees' influence in the company's decisions and activities. It is the manager at CB who is the driver behind becoming more sustainable. Concern about the environment is more recent, however, and not very well developed.

CB and indicators

CB does not currently use any indicators except from economic figures it needs for financial statements and annual reports, which are affecting the economic part of sustainability. CB has used some indicators in the past, but it is currently are not using any indicators because it did not have enough time to follow up and measure the indicators. The following indicators are those that CB is interested in measuring, based on the information that was extracted from the interview: **economic** (return on each deal, amount of won tenders, amount of productivity, number of satisfied customers), **environmental** (quality of the product, amount of transportation, lifetime of the products), and **social** (number of satisfied employees).

6.3 Company C

Company C's (CC) main business is to design and sell regulatory sanitary water economizing products with a focus on showerheads. CC designs the showerhead and outsources the production locally. The CC showerhead differs from common showerheads as it has a special design to reduce sanitary risks, especially the risk of legionella. It consumes less water, which results in a reduced energy consumption. The showerhead is modular and the end part can easily be replaced. This is important from a hygienic point of view, and sanitary regulations in publically-accessible institutions require regular replacement of sensitive equipment. With a replaceable end part, it can be changed on a more regular basis, which can lead to a decrease of risk of legionella. The main customers are hospitals, clinics and holiday centers.

CC and sustainability

The manager of CC has a big personal interest in sustainability, which is reflected throughout the company's business. His main concern is for environmental issues. The materials in the showerheads are selected carefully to have as little impact on the environment as possible. He initiated studies from the beginning to perform environmental analysis on his products, and has proposed take-back schemes to manage and recycle products so that he can reuse the materials. Indeed, the showerheads cannot be reused for sanitary reasons, so CC recycles the used materials to produce new ones. The manager moved the production to Saint-Etienne to be able to produce the products locally. He is also studying the possibility of using 3D printers to make the products in the future; this would enable production wherever his customers are situated, as well as reduce the amount of transportation needed. In addition, the manager also highlights an interest in circular economy.

CC and indicators

When questioned about indicators, the manager expressed that the company uses a variety of indicators. The indicators that CC uses today are used more as a checklist for eco-design during the development of the products, rather than as actual indicators. The indicators are not followed up or measured on a regular basis. Therefore, the method to measure the indicators was not developed and the indicators do not cover the business in general, but are more focused on product development. The indicators that the company uses are: **raw material** (type of material), **manufacturing** (components and parts manufactured externally), **use** (functionality, durability, user habits, assistant material, circumstances of use, waste and emissions, maintenance, repair), and **end-of-life** (disassembly, refurbishment and reuse, recycling, elimination).

The indicators CC mentioned as something that it wished to implement to measure on a more regular basis were the following: **economic** (number of satisfied customers, design aspects of the product, number of positive contracts from customer meetings), **environmental** (amount of water used, amount of energy used, amount of transportation, amount of materials used, amount of recycled materials used, amount of products being recycled after end -of-life, amount of recuperation of waste), and **social** (amount of local production, amount of local employment, health (amount of legionella bacteria)).

The economic indicators mentioned during the interview were the number of satisfied customers and the design aspect of the products. The company found the design aspect important as it has had customers with different opinions regarding the design of the products, and it wanted a concrete method to compare different designs. From an environmental point of view, CC was interested in measuring the amount of water and energy consumed, transportation, the type of materials used, recycled materials and products recycled after end-of-use. The company was interested in more or less all of the indicators that were presented, suggesting that it had difficulties with prioritizing. On the social level, the amount of local production, local employment and the quantity of legionella bacteria were indicators relevant for CC.

6.4 Summary of Environmental indicators

During the empirical investigation the following 11 environmental sustainability indicators were found (Table 3).

Table 3. Environmental sustainability indicators of the case companies studied.

Environmental sustainability indicators	CA	CB	CC
Amount of transportation	X	X	X
Amount of energy used	X		X
Use of equipment	X		
Quality of the product		X	
Lifetime of the products		X	
Amount of water used			X
Amount of recycled materials used			X
Amount of materials used			X
Amount of recuperation of waste			X
Health (amount of legionella bacteria)			X
Number of products being recycled after end-of-life			X

7. Discussion

From the empirical research, one can conclude that there are two main reasons why companies are working with PSS:

1) Economic motivation to meet customer demand. The first reason has to do with customers not wanting to own the product, but rather get the value that the product can produce, and without problems such as maintenance and repair. The companies wish to meet this customer demand.

2) A strong belief in PSS helping the company to become more sustainable. The second reason was found when companies are working devotedly to becoming more sustainable, and they have found that PSS could be a means to help them accomplish that.

The reasons why the companies are working with PSS could be a key to which indicators interest them the most, as the companies focused on customer value are more focused on customer satisfaction and economic benefits, while the companies focused on sustainability are more interested in environmental indicators. From the three different aspects of sustainability -

economic, environmental and social - it was the socio-economic aspect that was the most important for companies CA and CB, and the environmental aspects that were the most important for company CC.

Regarding their familiarity with and use of indicators, each company had different experiences and relationships to the indicators. Two of the companies, CA and CC, used many different indicators and were familiar with working with indicators. But even if they used indicators, they used them very differently; CA was the one with the most developed indicators, and which measured its indicators each month and followed up on the results. CC, on the other hand, claimed to use a lot of indicators, but the indicators that it did use served as a checklist when designing an offering, and were not something that was measured on a regular basis. From this, one can conclude that a bigger company has more resources in the form of workforce to select, follow up and evaluate the indicators, whereas a smaller company like CC has difficulties in using indicators to the same extent.

For environmental indicators, the industrial sector has an impact on which indicators the companies are interested in measuring. For example, company CC, which works with water and water consumption, has interest in using an indicator to measure the water consumption to show the water-saving efficiency of its products. CA, whose machines consume large quantities of energy, was most interested in measuring the use of electricity to sell fully operational and optimized plants rather than selling machines. The same pattern would probably repeat itself if, for example, a company working with pest management were to be asked. Such a company would probably find biodiversity or the amount of productivity of the agriculture as important indicators to measure. Beyond the environmental aspects, the indicators that all of the companies mentioned as being important were client relation and customer satisfaction, and one can therefore conclude that those are the most important indicators for the different companies. All the companies need to understand the customer needs to better be able to meet them, as there is no point in delivering a service that the customers do not have a need for. Another important aspect of indicators concerns internal issues. CA and CB, in different manners, stress the importance of their employees and the necessity to maintain their jobs. CC outsources production and is therefore more concerned with local employment. All three companies are deeply rooted in the territory (local production, employment).

From the empirical research, one can conclude that the sustainability work and progress awareness mostly depends on the **size**, **personal interest** and **maturity** of the company. Their awareness is here determined by how many, how well developed and how often they follow up on the indicators that they use to measure their sustainable impact.

The **size** of the company has an impact, as a larger company can have more resources in the form of workforce to develop and follow up on its sustainable impact, especially in comparison to a smaller company that simply does not have the same resources. A larger company can allow itself to have more specialized staff and can also have a stronger financial situation, which allows it to not only focus on its core business, such as production, but to also take the time to consider its impact on society. Smaller companies cannot put away enough time to create and follow up on indicators; what they need are indicators that are easy to use and easy to measure. CA was the biggest company in the research study, and also had the most developed indicators, even if all the indicators that it uses were not indicators to measure sustainability.

Personal interest is an important factor, as it is crucial to keep in mind that all companies are not working with PSS in order to become more sustainable. Companies with employees that are more interested in becoming sustainable are also more aware of how they perform regarding sustainable aspects. An example from the research to confirm these suggestions is the company CC, which is a smaller one-man company but still has a deep understanding about sustainability and how it can improve its sustainability impact, in this case because of a high personal interest in sustainability.

Another factor is the **maturity** in which the companies work with sustainability, i.e. how long they have actively worked on becoming more sustainable. CA, which is the oldest company in the research, has the most developed indicators and has had the time to develop its indicators according to its needs.

It is also important to keep in mind that all companies working with PSS are not interested in becoming more sustainable from an environmental or social point of view. They are often using PSS for economic reasons and to meet customer demand, and that is important when developing indicators, as they are probably more interested in developing economic indicators.

8. Conclusion

The objective of the paper was to find a set of indicators to use when developing PSS offerings to help measure progress in terms of sustainability and particularly environmental issues. A conclusion was that one of the most important things when working with indicators is to have them adjusted to each company's need, and to limit the number of indicators as much as possible to minimize the extra work that has to be done when using them. The indicators used during the interviews could instead be used as a starting point for discussion within a company regarding which indicators it wants to use when measuring its progress. Thus, indicators can be seen as inspiring and giving ideas on what to focus on.

Even though the concept of PSS was first developed in order to be a more sustainable business model than traditional product sales, and PSS could be a way to enable companies to become more sustainable, sustainability is not always the main reason why companies work with PSS. From a company perspective, besides helping it to become more sustainable, the benefits of providing PSS could be more regular customers and as well as giving the company better control of its products. What one can see is that on an economic level, customer satisfaction is an important indicator that concerns all the companies interviewed. On an environmental level, it was clear that the indicator depends on which sector of activity the company is in; for example, a company working with water consumption naturally has a special interest in the amount of water consumed.

Some companies already use indicators to measure their progress and their current state, and from this research one can conclude that more established and bigger companies have a better possibility to use indicators. To enable smaller and less

experienced companies to use indicators, the indicators should be limited and easy to use. When developing a set of indicators to use, it is important that they are in line with what the company needs, and if they are developed in cooperation with future and current customers, the customer relationship could possibly grow even stronger.

One conclusion that can be drawn is that it is important to develop the PSS offering and the indicators in cooperation with current and future customers, as the customer relationship is a key factor for success. The number of indicators to measure is also another concern to keep in mind. It is important to focus on a few indicators so that the process to follow up and measure the indicators does not take time from the rest of the work that needs to be done. It is therefore important to carefully select indicators that really are useful for each company.

9. Future research

Further research should extend these questions to other SMEs and cross practical SME concerns with the large number of indicators available. The SMEs must develop objectives using some of the selected indicators and establish scenarios to make them possible.

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